

DISTRIBUTION AND HABITAT USE OF WESTERN POND TURTLES IN A SEASONAL IMPOUNDED RIVER



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ABSTRACT

The western pond turtle (Clemmys marmorata) inhabits a variety of lotic and lentic habitats, including altered habitats such as small reservoirs and other impounded waterways. Although, this turtle is widespread and exhibits plasticity in habitat use the species is in decline. This study determined the distribution and habitat use of the western pond turtle above a seasonal dam along the Russian River, Sonoma County, California. The seasonal dam creates an approximately 5.1-km-long reservoir called the Wohler pool with an area of approximately 360 ha. The common use of living downed trees with trunks of moderate size, averaging 20.7 cm, by basking turtles indicated that an intermediate-staged riparian forest is necessary to maintain the current habitat. This turtle population did not appear to be adult-biased with no recruitment, as thought to be a sign of decline in other areas of the state. Turtles had a broad range of age classes, including 26.9% juveniles. Western pond turtles are resident of the Wohler pool; however, their numbers decreased downstream. Important factors in the persistence of turtles are probably the temporary nature of the impoundment and the gradual effects of the reservoir from upstream to downstream. This is consistent with the observed relatively high abundance of turtles in the upper reach of the Wohler pool and the gradual decrease with proximity to the dam where the effects of the impoundment are greatest.

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INTRODUCTION

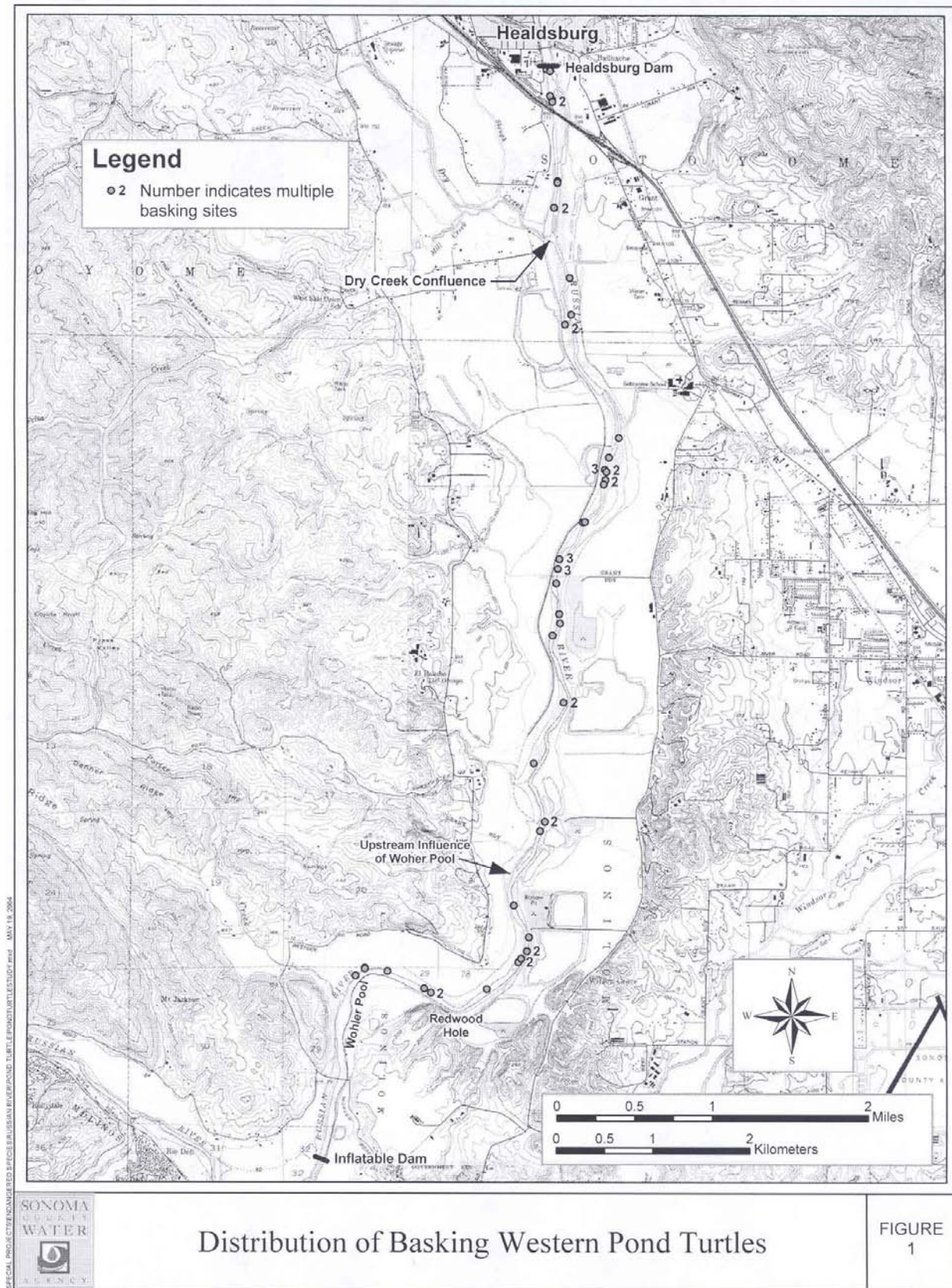
The western pond turtle (*Clemmys marmorata*) is the only extant native aquatic turtle in California. This species inhabits a variety of lotic and lentic habitats, including streams, rivers, estuaries, ponds, marshes, and lakes (Zeiner et al. 1988). In addition, artificial or altered habitats are utilized, such as canals, excavated ponds, reservoirs and other impounded waterways (Holland 1991). Although, this turtle is widespread and exhibits plasticity in habitat use the species is in decline (Holland 1991; Jennings and Hayes 1994). Populations in Southern California are in danger of extinction (Jennings and Hayes 1994) and throughout the state it is considered a Species of Special Concern by the California Department of Fish and Game. Primary reasons for the decline of the species are the loss or alteration of habitat. Habitat loss in the Central Valley of California has extirpated many populations (Holland 1991), although some remaining extant populations appear stable (Germano and Bury 2001). In the north coast of California western pond turtles are widely distributed (Holland 1991), but trends in decline have been reported (see Jennings and Hayes 1994).

Dams can alter or eliminate stream habitat for western pond turtles (Holland 1991) and viable populations are not known to occur in reservoirs greater than 2-3 ha (Holland 1991). Large reservoirs often have fluctuating water levels that preclude the establishment of bank vegetation needed for basking, cover, and foraging. Dammed rivers alter downstream habitat and suitability for western pond turtles by decreasing water temperatures, increasing velocities, and increasing canopy cover (Reese and Welsh 1998a). Dam-altered rivers may effect turtle recruitment (Reese and Welsh 1998b) resulting in adult biased populations that are not viable in the long-term. Essential habitat features for western pond turtles include areas with slow-moving waters and basking sites to thermoregulate body temperatures (Holland 1991). Emergent basking sites are usually composed of exposed logs, rocks, and emergent vegetation, which can be effected by altered flow regimes from dams.

The purpose of my study was to determine the distribution and habitat use of the western pond turtle above a seasonal dam along the Russian River, Sonoma County, California. The Sonoma County Water Agency operates an inflatable dam that creates an approximately 5.1-km-long reservoir called the Wohler pool. The dam is usually in operation from late spring through fall, which coincides with the activity period of turtles. The objectives of the study were to: 1) determine what basking habitat features are important, 2) characterize the population structure, and 3) determine the distribution and abundance in the study area.

STUDY AREA

The study area consisted of a 14.8-km-long reach of the Russian River from Healdsburg dam, Healdsburg to an inflatable dam located downstream approximately 0.9 km below Wohler Road Bridge (Figure 1). The Russian River within the study area is characterized by moderate to slow moving water with an average slope of 0.45%. In general, the riparian forest is well



Distribution of Basking Western Pond Turtles

FIGURE 1

developed and has a patchy distribution. Historic and recent levees along the banks of the river occur throughout most of the study area. Surrounding land use includes infiltration ponds, pit gravel mining, and vineyard.

The study area is influenced by 2 seasonal summer dams that are located at the ends of the study area, which impound water for recreation and municipal uses. The river within the study area is free-flowing from the upstream end at the Healdsburg dam for approximately 9.7 km. The lower 5.1 km of the study area is impounded from the inflatable dam. The Healdsburg dam has a 3-m-high permanent concrete base and 3-m-high flashboards that are installed during summer. The inflatable dam, located at the downstream end of the study area, consists of a 3.4-m-high rubber bladder that is inflated during summer. This dam impounds water creating a 5.1-km-long narrow reservoir, called the Wohler pool, and is located within the study area (Figures 1 and 2). The surface area of the Wohler pool varies but is approximately 360 ha. For study purposes, the Wohler pool was divided into lower, middle, and upper reaches determined by geographic and hydrologic characteristics. The dam substantially influences aquatic conditions in the lower and middle reaches of the Wohler pool by increasing water depths and temperatures, decreasing velocities, and flooding bank vegetation. The upper reach of the Wohler pool has minimal influence from backwatering and has a maximum depth change of 0.2 m at the lower end and no effect at the upper end.

The summer stream flows in the Russian River are augmented by 2 large permanent dams located upstream of the study area. Historically, the Russian River probably had limited summer flows and likely dried in areas. Currently, water releases from the dams maintain perennial flows in the river. Coyote Dam at Lake Mendocino, near Ukiah, impounds the East Fork of the Russian River and is located approximately 106 km upstream of the study area. Warm Springs Dam and Lake Sonoma are located on Dry Creek approximately 22 km above the confluence with the Russian River. Dry Creek is a major tributary of the Russian River and has its confluence approximately 2 km downstream from the Healdsburg dam and from the upstream end of the study area.

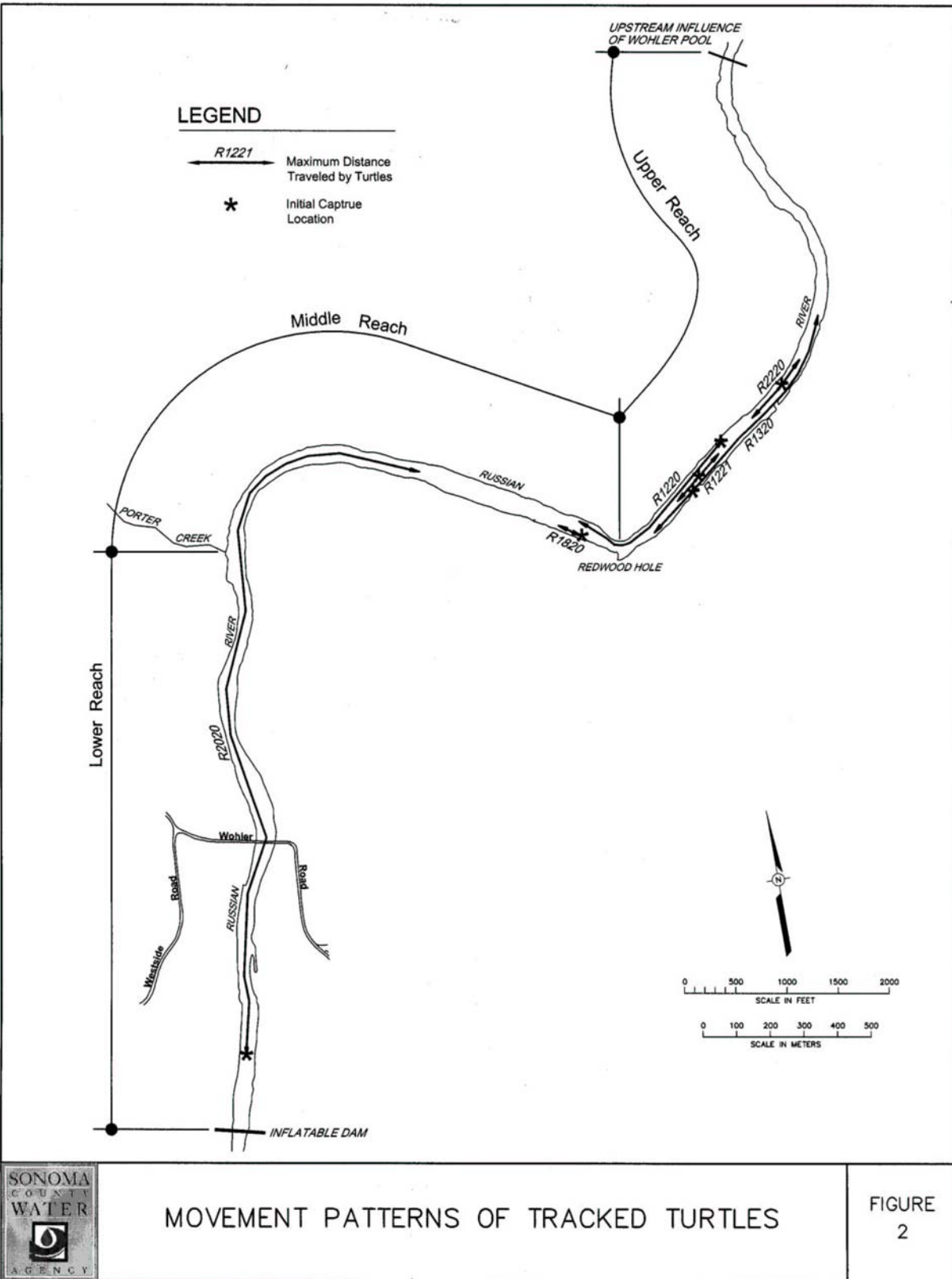
METHODS

Visual Surveys

A 2-person crew conducted visual surveys to detect basking western pond turtles and systematically collect habitat data at basking sites. We conducted 6 surveys on warm sunny days from 17 June through 2 September 2003 by floating downstream in kayaks and searching the river banks for turtles. Visual surveying for basking turtles is an effective method to detect juveniles and adults. Hatchlings and very young turtles spend most of their time in areas with dense emergent vegetation (Jennings and Hayes 1994) and likely went undetected. At all observed basking sites, we collected habitat data, determined the coordinates using a Garmin GPS III Plus global positioning system (GPS), and marked each site to avoid resampling.

Dive Surveys

Study crews conducted dive surveys using snorkel equipment to capture turtles throughout the study area from 2 July through 2 September 2003. We kayaked the study area and visually searched for basking turtles. Once turtles entered the water, we searched underwater and



MOVEMENT PATTERNS OF TRACKED TURTLES

FIGURE 2

hand captured individuals. Captured turtles were measured (carapace length, CL), sexed, uniquely marked by filing notch(es) along the edge of marginal scutes, and released at the point of capture. Also, age was determined by counting growth rings on the carapace and plastron of turtles (Bury and Germano 1998). We grouped turtles into 3 age categories, including juveniles, young adults, and mature adults. Juveniles were sexually immature turtles ≤ 120 mm CL (Germano and Bury 2001) and 1 to 5 years of age. Young adults were based on our ability to detect growth rings on turtle ages 5 to 9 years. Turtles with ≥ 10 rings or no visible rings from worn shells were considered mature adults.

Radio Telemetry

We radio-tagged 6 adult western pond turtles captured within the Wohler pool on 2 and 3 July 2003. We captured turtles during dive surveys and by using commercially made 1-m-diameter hoop traps with nylon mesh. Hoop traps baited with sardines and beef liver were installed near the inflatable dam (4 traps) and in the upper Wohler pool (5 traps). Radio-tagged turtles received small microprocessor coded transmitters (9.2 mm diameter, 20 mm length, 2.0 g weight, antenna length 30 cm) attached to the middle of the carapace with epoxy glue, and were released at the point of capture. Tags transmitted on 5 frequencies in the 149 MHz band. The use of coded transmitters permitted the unique identification of all turtles. Minimum transmitter battery life was approximately 4 weeks.

We tracked the location of turtles 1 to 3 times per week from a two-person kayak using an H-antenna and scanning receiver. The coordinates of tracked turtles were recorded with a GPS when transmitter signal strength was maximized. On 2 occasions, we supplemented kayak tracking surveys with vehicle tracking surveys on nearby roads when turtle R1220 could not be found in the river.

RESULTS

Distribution and Movement Patterns

The spatial distribution of western pond turtles was clustered and sporadic throughout the study area (Figure 1). Turtle observations ranged from 0/km to 11/km in the study area with no apparent pattern in relation to Healdsburg dam, Dry Creek confluence, and the Wohler pool (Figure 3). The 1-km segment above the inflatable dam was the only section with no observed turtles, although we trapped 1 western pond turtle in this segment, as discussed below. The closest basking turtle observation above the inflatable dam was approximately 1.9 km upstream.

The 6 radio tracked turtles varied in their movement patterns but all remained within the Wohler pool where they were originally captured (Figure 3 and Table 1). Three turtles (R1221, R1320, and R2220) were captured and remained in the upper reach, while R1820 utilized the upstream end of the middle reach. Two turtles utilized two reaches of the Wohler pool. R1220 utilized the upper reach and the upstream 150 m of the middle reach, and R2020 utilized the lower and middle reaches. The average maximum river distance moved by turtles was 666 m (range 100 m to 2,309 m). A gravid female turtle (R1221) radio tagged on 3 July 2003 had the shortest movement distance of 100 m. We recaptured turtle R1221 on 7 August 2003 and she was no longer gravid. We did not detect any terrestrial movements of R1221 and she apparently deposited her eggs and returned to the river between our tracking surveys. Another radio-tagged

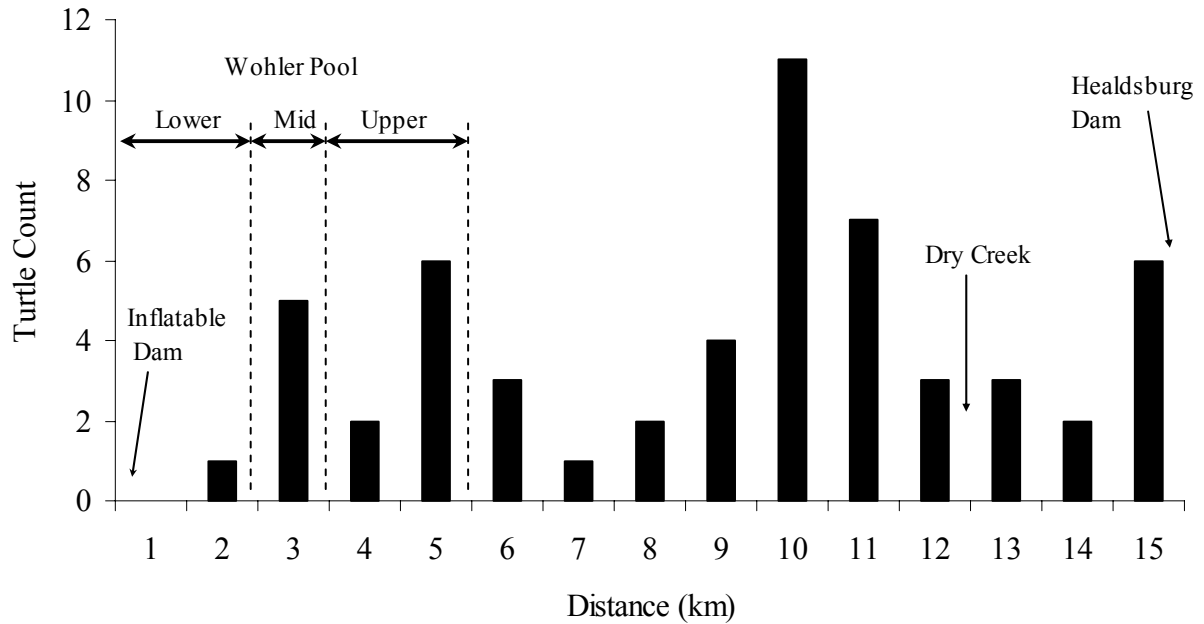


Figure 3. Distribution of basking western pond turtle observations. Distances begin at the inflatable dam (0 km) located at the downstream end of the study area and extend upstream to the Healdsburg dam.

Table 1. Radio-tagged turtle characteristics and movement distances in the Wohler pool.

Turtle No.	CL (mm)	Sex	Age	Maximum Distance (m)	Reach Utilization
R1220	159	M	6	462	Upper / Middle
R1221	159	F	10+	100	Upper
R1320	162	M	10+	794	Upper
R1820	143	M	10+	108	Middle
R2020	166	F	6	2309	Lower / Middle
R2220	160	F	5	227	Upper

female turtle (R2020) had the longest movement at 2,309 m. She was captured in a hoop trap 151 m above the inflatable dam on 3 July 2003 at 4:00 pm. On the following morning at 11:00 am, 19 hours later, R2020 had moved upstream 762 m. We tracked her location 4 days later an additional 1,241 m upstream, where she remained in the vicinity at least until 28 July 2003. The other 4 radio-marked turtles remained in the upper Wohler pool, where the influence of the inflatable dam is limited, during the entire tracking period. R1220 was tracked until July 14 when the transmitter apparently malfunctioned.

Population Structure

We found the western pond turtle population in the study area to have a well-developed age structure (Figure 4). The carapace size of western pond turtles corresponded with age estimates from growth rings ($R^2 = 0.8806$, $n = 31$). We were able to estimate the age of 1 turtle as old as 11 years (i.e., 11 growth rings), but our limit for detecting individual growth rings was usually 9 or 10 rings. The age classes that we could determine (ages 1 through about 10) were all detected in the study area, except for 2 year old turtles. Very young turtles do not typically bask out of water (Jennings and Hayes 1994). Consequently, age classes of 1, 2, and possibly 3 year old turtles were probably underrepresented in our surveys. The composition of age classes included juveniles (26.9%), young adults (30.8%), and mature adult (42.3%). Male western pond turtles composed a slightly larger proportion of the population than females at a 1 : 0.77 ratio. The average carapace size differed slightly between the sexes ($X_{male} = 172.6 \text{ mm} \pm 17.5$; $X_{female} = 167.4 \text{ mm} \pm 6.2$).

Habitat Use

We regularly observed western pond turtles basking along the margins of the Russian River during our study. Downed trees (i.e., logs/snags) consisted of 93.7% of the observed basking sites. Other basking sites included exposed rocks, metal debris, and flotsam material. Log basking sites were associated with the riparian forest located along the margins of the river. Basking sites were located close to shore ($X = 2.81 \text{ m} \pm 1.45 \text{ m}$, range 0.6 m to 9.1 m, $n = 108$) where downed riparian trees were most prevalent.

Western pond turtles showed a narrow use of several habitat basking features (Figure 5). Turtles used a variety of basking log types but their use was highest with the more recently formed basking sites and decreased with the deteriorating condition of logs (Figure 5A). We did not quantify basking types available to western pond turtles; however, we did not observe turtles crowded on any particular basking type, suggesting that preferred basking types were not a limited resource. Living downed tree logs constituted 34.6% of the observed basking sites, while decomposed snags were used less frequently at 3.8% (Figure 5A). Recently created basking sites are formed by winter flooding that scour the roots of riparian trees and topple into the river. Living downed tree logs had the characteristic of numerous twigs and small branches that appeared to add difficulty for turtles to haul out on. The average diameter of basking logs was 20.7 cm (range 3 cm to 70 cm; Figure 5B).

Cover appeared to be an important feature in basking site use. Canopy cover above basking sites varied from open to completely closed canopy, and 64% of all basking sites had >20% canopy cover (Figure 5C). Water depth at basking sites had a near normal distribution with a skewness of 0.01. The mean depth used by turtles was 1.45 m (Figure 5D). We did not quantify

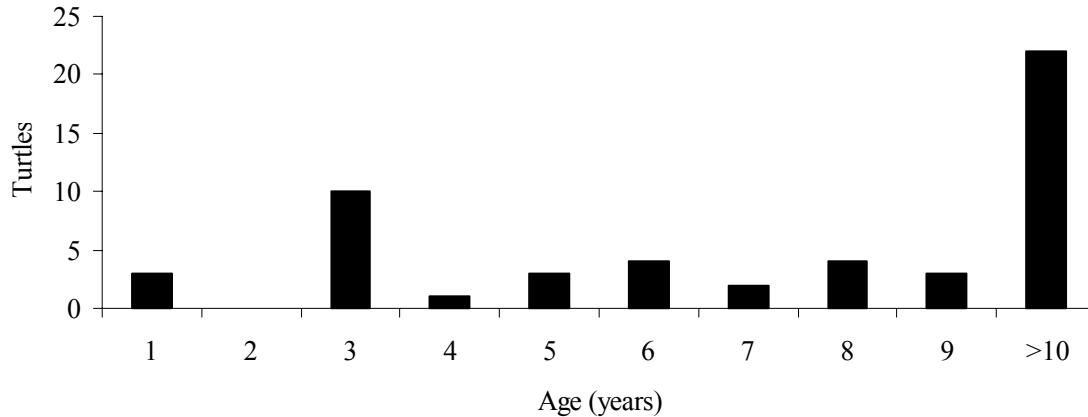


Figure 4. Age structure of western pond turtles based on annual growth rings (n = 52).

submergent cover (i.e., wood debris, exposed roots, undercut banks, etc) beneath basking sites; however, an abundance of submerged cover was observed during our dive surveys at all basking sites.

DISCUSSION

Habitat Use

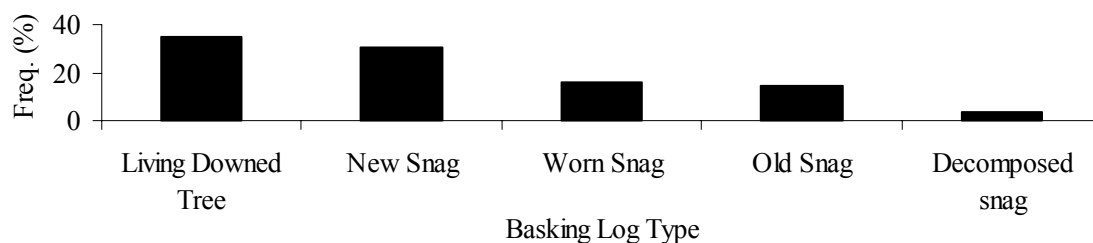
The common use of living downed trees with trunks of moderate size, averaging 20.7 cm, for western pond turtle basking (Figure 5) indicates that an intermediate-staged riparian forest is necessary to maintain the current habitat for western pond turtles. Reese and Welsh (1998) found a similar association with intermediate successional forest and indicated that deep water with low velocities and the presence of exposed basking and underwater refugia are important habitat features. Riparian trees within the winter flood zone are necessary for scour-pool formation and to provide slow or slack-water habitat for turtles. Downed riparian trees provide basking sites, as well as submergent cover utilized by turtles.

The conventional purpose for aerial basking is to maximize solar exposure for thermoregulation. The use of living downed trees by turtles in this study with an abundance of small attached branches and shade is counter to this concept. A benefit to these apparent restrictions to aerial basking is protection from terrestrial predators. In addition, the use of basking sites with as high as 100% canopy cover suggests that aerial basking may be for ambient air temperatures and not necessarily direct solar basking.

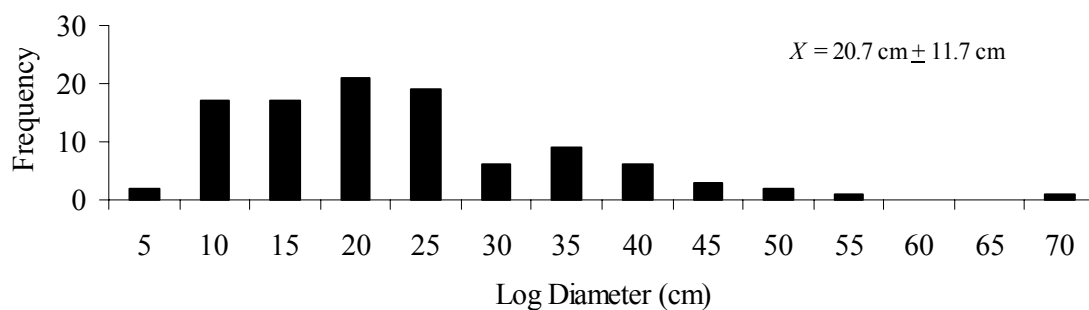
Population Structure

The abundance of western pond turtles in the study area is likely a fraction of the historic number present prior to intense development in the area. However, the western pond turtle population does not appear to be adult-biased with no recruitment, as thought to be a sign of decline in other areas of the state (Jennings and Hayes 1994). Western pond turtles are a long-lived species and a large proportion of a viable population are expected to be adults. Turtles in the study area had a

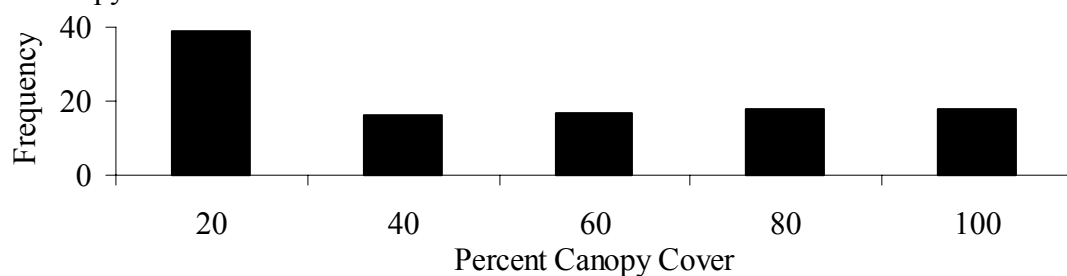
A. Log Condition



B. Log Diameter



C. Canopy Cover



D. Water Depth

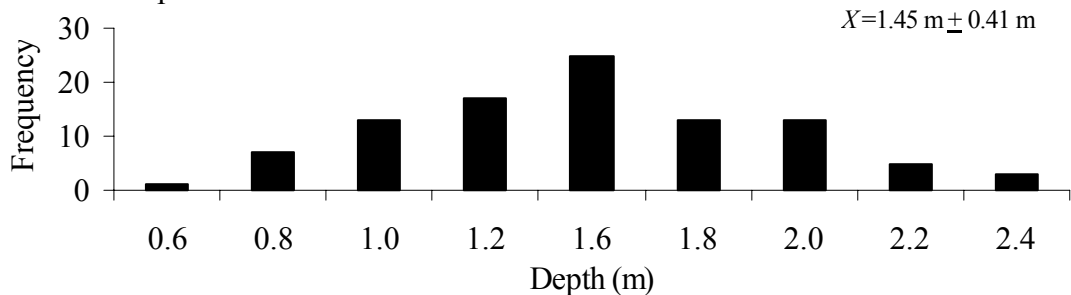


Figure 5. Habitat characteristics of observed basking western pond turtle sites, $n = 104$. (A) Log condition based on Living Downed Tree = living branches with leaves; New Snag = small branches attached, rough/splintered edges, bark present; Worn Snag = medium branches attached with worn ends, bark partially present; Old Snag = trunk present with worn ends, bark absent; Decomposed Snag = large trunk with soft wood.

broad range of age classes including 26.9% juveniles, which is similar to a stable population with a reported occurrence of 35.2% juveniles (Bury 1972; Reese and Welsh 1998b). This suggests that although the turtle population in the study area may be lower than historic levels it is currently stable.

Distribution and Abundance

This study has shown that western pond turtles are resident of and occur throughout the Wohler pool. The Wohler pool, with an area of 360 ha, is 60 to 120 times the maximum size of reservoirs thought to contain viable populations (Holland 1991). Important factors in the persistence of turtles are probably the temporary nature of the impoundment and the gradual effects of the reservoir from upstream to downstream. This is consistent with the relatively high abundance of turtles in the upper reach of the Wohler pool and the gradual decrease with proximity to the dam where the effects of the impoundment are greatest. Also, radio-tagged western pond turtles remained in the mid- to upper reaches of the Wohler pool, except for R2020 turtle that was captured in the lower Wohler pool and then spent most of the time in the middle reach. Movement patterns of radio-tagged turtles ranged from near sedentary to long-distance movements within a few days, which are similar to reports from other populations (Holland 1991; Rathbun et al. 1992; Goodman and Stewart 2000; Holland 1994; Reese 1996).

The low observation of western pond turtles in the lower Wohler pool may have been biased by the selected sampling techniques (Ream and Ream 1966). Germano and Bury (2001) found that visual surveys underestimated western pond turtle populations and trapping surveys were more effective. In the lower Wohler pool no basking western pond turtles were observed. Trapping surveys captured a single turtle (R2020) near the dam indicating that turtles do occur in the lower Wohler pool, although this turtle spent most of the time in the middle reach of the Wohler pool. This data suggests that the lower Wohler pool, where the influences from the dam are greatest, is utilized by western pond turtles but at relatively low frequencies compared to other areas. As mentioned above, we did not quantify basking habitat available to western pond turtles, but we did observe a variety of log types within the Wohler pool that appeared suitable for basking.

The reasons for the observed distribution pattern of western pond turtles in the Wohler pool are unclear and are likely affected by confounding biotic and abiotic factors. The slack water areas in the lower Wohler pool appear to have suitable foraging and basking habitat for turtles. Higher water temperatures and increased numbers of fish predators do not appear to be major factors in turtle distribution. Chase et al. (2004) estimated that Wohler pool average temperatures increased by only 0.16° C and the fish assemblage was similar to other reaches of the Russian River during the turtle study. Food abundance may be an important factor in turtle distribution and warrants study.

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